Pioneers

4. Charles Wheatstone (1802-1875) – Master of telegraphy

W.A. ATHERTON

Sir Charles Wheatstone and his family: this stereoscopic daguerreotype is in the National Portrait Gallery, London.

It is an irony indeed when a prolific inventor is mostly remembered for an invention that was not his.

Charles Wheatstone did not invent the Wheatstone Bridge. He did however invent the concertina, one of the first electrical relays, the rheostat, a solar clock, improvements to the mouth organ, a typewriter, a binocular 3-D viewer similar to the modern toys, a stethoscope which he called a microphone, and some of the best 19th century telegraph systems – amongst other things.

Born in Gloucester on the 6th February, 1802, Wheatstone was the son of a music seller. He was educated at a private school but had no formal scientific education.

At 21 he was living in London where he and his brother had entered the business of making and selling musical instruments. Those instruments, and the related science of acoustics, were to figure large in his life.

Although as yet an outsider to established scientific circles, he received a visit from Oersted in 1823. His first scientific paper was read to the French Académie des Sciences that year by Arago and published in London, all at the age of 21.

As part of his study of musical instruments, in 1821, Wheatstone had demonstrated an 'enchanted lyre'. This was an entertaining application of the transmission of sound through a solid rod. A sounding board, in the shape of a classical lyre and apparently hanging from the ceiling, appeared to play music! It was in fact amplifying sound vibrations conducted to it by a rod from a piano in an upper room.

This early fascination with the passage of sound waves through a solid rod helped to turn Wheatstone's thoughts to telegraphy, the art of sending messages over a distance. He described the enchanted lyre to the Royal Institution of London in 1831 and reported that sound travelled through a solid rod about 16 times faster than through air. It would, he said, travel the distance of 200 miles in less than a minute – if a suitable conducting substance could be found. His thought, even then, was to transmit messages. Speech, he had already found, could be transmitted over short distances "perfectly, though feeble."

The "almost hopeless difficulty" of a breakthrough for long distances, he wrote, "might induce us to despair of further success." The answer, he speculated, lay with a mechanical speech synthesizer! Bell's telephone was to be invented shortly after Wheatstone's death.

In 1833, however, his attention turned to electricity, and in particular the question of its speed of transmission. It was known to be extremely fast, so fast that no-one had been able to measure it. Wheatstone provided the breakthrough.

His genius lay in devising a method of measuring the tiny intervals of time between three sparks located at the beginning, middle and end of half a mile of wire. This measurement of minute amounts of time had defied everyone else. His solution, using a revolving mirror, was simple and effective. It became a laboratory classic. He even attached a siren to the hand-cranked mirror so that the tone it generated helped him to govern the speed of rotation.

Wheastone's measurement of the speed of electricity was much too high, but it was of the right order and the first to be achieved. Later with four miles of wire he revised the figure to 192 000 miles per second, much closer to the present-day value of 186 000. Partly as a result of this huge success he was appointed Professor of Experimental Philosophy at King's College, London, a position he retained for life.

But standing before an audience filled him with terror and he gave few lectures. At the Royal Institution his scientific papers were read for him by Michael Faraday who was an enthralling speaker. It is said that on one occasion, when due to speak himself, Wheatstone fled leaving Faraday to pick up the pieces.

THE TELEGRAPH

'Who invented the electric telegraph?' is, as politicians say, a very good question.

To the modern mind Morse's name comes most readily; but while he was one of the most successful telegraph inventors, he was not the first. Wheatstone could justifiably claim to have invented the first telegraph system to be put into daily commercial operation. In partnership with W.F. Cooke

he installed a telegraph able to send and receive messages between London (Paddington) and West Drayton along the Great Western Railway from July 1839 and it operated on a daily basis for 10 years, even being extended as far as Slough. It was from this that the British telegraph system sprang.

Even so, it was not the first electric telegraph. Once the magnetic effects of a current were known (1820) several telegraphs using magnetic needle detectors were invented as the same idea came to different people in different places.

Probably the first to produce an experimental electromagnetic-needle telegraph was a Russian baron, P.L. Schilling, perhaps as early as 1825. Although he died in 1837, samples of his equipment had been sent to friends abroad and one of them was seen in Germany by William Fothergill Cooke. Fired with enthusiasm, Cooke returned to England with burning ambitions to build telegraphs – especially for the railway companies, his first potential customers. His partnership with Wheatstone led to commercial telegraphy.

Amongst several remembered for their experiments with electric telegraphy around this time are the Gauss and Weber partnership in Germany, Edward Davy and William Alexander in Britain, and of course Morse in America.

On his return to England Cooke sought help to solve the problem of how to get his telegraph to work over long distances. Over a mile his results were poor. He turned to Wheastone in February 1837 only to discover that the scientist already had his own ideas for a telegraph, and a knowledge of electricity, and success with four miles of wire. Whilst Wheatstone provided the technical expertise and scientific knowledge, Cooke supplied the drive and vision necessary for commercial telegraphy to become a reality.

In April that year Wheatstone received a visit from the great American scientist Joseph Henry, and learned of Henry's outstanding work on electromagnets and their operation through long lengths of wire. A missing scientific link slotted neatly into place.

A partnership was formed, at times very acrimonious and in need of arbitration to settle disputes. Patents were acquired, and after trials and tribulations, success came with the Paddington to West Drayton telegraph.

This was the famous five-needle telegraph now in the London Science Museum. Five wires were needed, one to each needle, any two of which could be made to complete a battery circuit. The current flowed out by one wire and back by the other. The choice of wires and direction of flow was dictated by a permutating keyboard and a letter was indicated on the diamond-shaped dial by the simultaneous deflection of two needles (Fig.1). The instruments were well designed and made, a characteristic of Wheatstone probably born during his apprenticeship as a musical instrument maker.

This telegraph was a huge technical success. In 1843 the line was extended to Slough by Cooke, a total distance of 19 miles, using only two needles with codes. Two years later it achieved fame when police in Slough telegraphed to Paddington the description of a man who had just murdered his mistress in Slough. His escape by train to London took him into the arms of the constables.

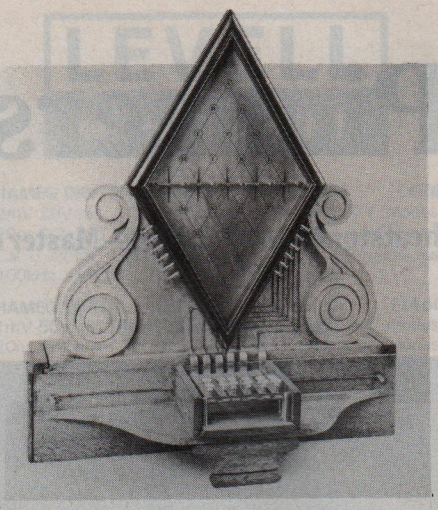


Fig.1. Cooke and Wheatstone five-needle telegraph, 1837 (Science Museum).

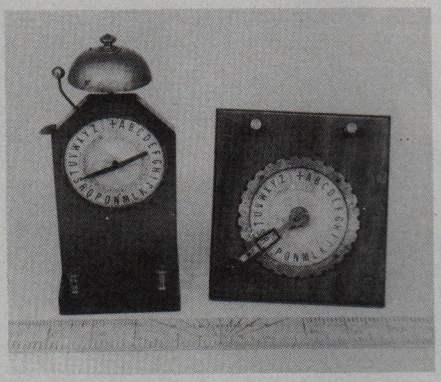


Fig.2. A simple ABC telegraph from about 1890-1900, bought with other 'junk' in an auction. It still works and is now in the hands of a collector. The transmitter is on the right.

By the end of 1845 the telegraph had arrived and the number of lines was increasing. The next year the Electric Telegraph Company was formed and Wheatstone received the healthy sum of £30,000 for his share of the patents. By 1870 the telegraphs had been nationalized at a cost of some £8 million.

Wheatstone had meanwhile turned to the design of ABC or 'letter showing' telegraphs. These had a dial with letters printed around the edge, only one of which would be visible. (or indicated) at any time. The first were essentially synchronized stop clocks with a remotely-operated electromagnet which could be used for stopping and re-starting the mechanism. The user simply noted down the letter shown each time the clock stopped.

Later, however, Wheatstone made the transmitter send multiple pulses down the line, each of which stepped the receiving dial on by one letter. Some of these devices were little bigger than a pocket watch and exquisitely made.

Although slow, ABC telegraphs were used in a sizeable network in London from 1860. Wheatstone's were not the only versions; they were made in several countries and some remained in use up to World War I.

Much faster than the ABCs was the Wheatstone automatic telegraph of 1859. Its successors were in use for over half a century. As with computers a hundred years later, paper tape was used to speed transmission, the message being coded by hand as punched holes which then drove a transmitter at high speed. Wheatstone's interest in coding developing into an interest in cryptography and he even deciphered some documents for the British Museum.

Charles Wheatstone made so many inventions they could fill a book. Just one suffices to illustrate his breadth of interests; a solar clock which used the polarization of sunlight to indicate time even when the sun itself was obscured. It was used on Arctic expeditions.

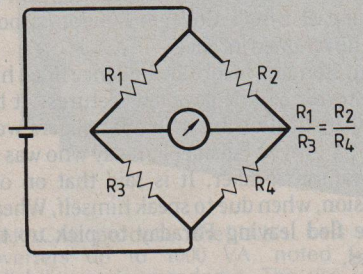
When Wheatstone died in Paris on 19th October 1875, a renowned scientist and inventor, he had received many and varied honours. The medals alone are said to fill a box of a cubic foot capacity. He sat on many important committees, was a Fellow of the Royal Society, and a foreign member of the French Académie des Sciences. Both Oxford and Cambridge Universities honoured him and he was knighted in 1868. He refused the Albert Medal of the Royal Society of Arts because they offered the same award to Cooke, his former partner. It was a bitter legacy of the tensions and disputes between them.

There was one unusual honour, though, of which Wheatstone may not even have been aware. In 1841, with Isambard Kingdom Brunel and others, he was aboard a locomotive when Brunel set out to discover how fast it could go. At about 90 miles per hour Wheatstone and his companions probably held the world land speed record!

Samuel Finley Breese Morse, the American artist and engineer, will be next in this series of pioneers of electrical communication.

The invention Wheatstone did *not* create

THE WHEATSTONE BRIDGE



In the early 1840s Wheatstone set out to obtain a firm basis for electrical measurements: voltage, current, and resistance. This was at a time when Ohm's law was still not widely known in Britain. Using Ohm's work, Wheatstone devised his own units and built a standard resistance. During this work he used the bridge principle described by Samuel Hunter Christie in 1833. Despite his giving Christie due credit for inventing the bridge it was Wheatstone's name which stuck.